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Standardizations of CPUE of striped marlin caught by Japanese offshore and distant water longliners in the north Pacific[1]

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Introduction

ISC marlin working group decided to conduct stock assessment of striped marlin in the north Pacific in 2005, assuming that striped marlin forming single stock in the north Pacific, except for coastal area of Mexico. This document reports the results of standardization of CPUE, which is used at the abundance index, of striped marlin caught by Japanese offshore and distant-water longliners in the north Pacific.

Materials and Methods

(1)GLM

Basic catch and effort data used in the analysis of CPUE was obtained from the Japanese longline fishery statistics compiled at the National Research Institute of Far Seas Fisheries for 1952-2002. Two kinds of Databases were used. The Database-I has the information of catch number and number of hooks aggregated by month and 5x5 blocks and rose to 100 percent coverage, while the new Database-II, starting from 1975, contains additional information for the gear configuration, i.e. the number of branch lines between floats. Standardizations of CPUE are conducted separately for the periods of 1952 – 1975 and 1975-2002, as difference in data quality. They are connected in 1975 after the standardization. Observations with less than 10,000 hooks are deleted from analysis.

The standardization of CPUE conducted by the GLM method with the model as follows;

Database-I

$$\ln(CPUE_{ijk}+const)=\ln(\mu)+\ln(YR_i)+\ln(QT_j)+\ln(AR_k)+\ln(INTER)+\varepsilon$$ ← 1952-75

Database-II

$$\ln(CPUE_{ijkl}+const)=\ln(\mu)+\ln(YR_i)+\ln(QT_j)+\ln(AR_k)+\ln(GE_l)+\ln(INTER)+\varepsilon_{ijkl}$$ ← 1975-2002

where ln: natural logarithm, $CPUE_{ijk}$: nominal CPUE (catch in number per 1,000 hooks, in year i, quarter j, area k), const: 1/20 of overall mean, μ: overall mean, YR_i: effect of year i, QT_j: effect of quarter j, AR_k: effect of area k, GE_l: effect of gear configuration l, INTER: interaction terms between YR*AR, YR*QT and AR*QT for Database-I, and YR*AR, YR*QT, AR*QT, AR*GE, and GE*QT. , and ε: normal error term. Analysis was made though the GLM procedure of computer software, "SAS Ver. 9.1".

Standardized CPUE was calculated for periods before 1981 from database-I and for periods after 1974 from database-II. Obtained two time series were connected using average ratio of estimated CPUE for the overlapping period (1975 – 1980).

Area stratification used in this study is shown in Fig. 1. Three different area stratifications were used in this study. One of them (stratification 1) was determined subjectively by the CPUE distribution patterns, and other two (stratifications 2 and 3) were obtained by the tree model analysis, and. The effect of gear configuration is represented with the number of hooks between floats (NHF) classified into seven categories (3-4, 5-7, 8-9, 10-11, 12-13, 14-18 and 19-23).

Because interaction term between AR and YR is significant, abundance index of each area is weighted by the approximate size of area and summed up to get total abundance index.

Results and Discussions

The trends of standardized CPUE by the three different area stratifications are shown in Figs. 2 - 4. In CPUE standardization by the stratifications 1 and 3, coverage of data were not enough to estimate the effects of interactions between year and area for all areas and years used. So, CPUE was standardized from data to get longest time series by selecting area with enough coverage of data as well as standardized from data to get widest area

coverage by selecting year. General trends of CPUE from these two different selected data were quite similar (Figs. 2 and 4). Historical trends of CPUE from the three different area stratification showed different results, which CPUE from the stratification 1 was most pessimistic and one from the stratification 3 was most optimistic (Fig. 5). These three CPUEs showed similar trends since late the 1980's, and standardized CPUE from the data of Japanese coastal longliners (1994 – 2004, Yokawa, 2005) also showed a similar decreasing trend for the periods between 1995 – 2004. This would indicate level of the stock decreasing at least in recent years.

Relatively high CPUE values were observed in area 8 (stratification 1) in the 1960's, areas 9 and 10 in the early 1970's, areas 12 and 13 from the 1960's to the early 1970's and from the late 1970's to the early 1980's, and area 11 from the 1960's to the early 1970's and the late 1970s (Figs. 8 and 9). Because the areas and periods with high CPUEs are roughly coincide with the occurrences of striped marlin directed sets (Yokawa, 2005), these high CPUEs would be positively affected by the directed sets. Thus, the model of CPUE standardizations used in this study could not fully adjust the effects of striped marlin directed sets which occurred rather sporadically. This indicates that rapid decreasing of CPUE observed in the 1960's and 1970's is overestimating the actual decrease of abundance level of striped marlin in the north Pacific.

Standardized CPUEs showed general decreasing trends in some areas such as area 6, 7, and 13 in the stratification 1 for the period of 1975 – 2004, while other areas such as areas 3, 4, and 5 showed general increasing trends in the same period (Fig. 7). These contradicting trends of CPUEs observed between some areas may suggest incomplete standardization of CPUEs of this study, and further investigation is necessary to improve the results of this study.

Standardized CPUEs by gear configuration and by area are shown in Figs. 8, 9, and 10 obtained from the stratification 1, 2, and 3. Taking into account the vertical CPUE pattern of striped marlin estimated by the longline research cruise data (Yokawa et. al., 2005) which indicates higher CPUE in shallower layers, a negative collation between the number of hooks between floats (HPB) and the standardized CPUE is a natural result. But, such relationship are only observed in 3 areas of 13 in the stratification 1, 5 areas of 8 in the stratification 2, and 3 areas of 9 in the stratification 3. In the CPUE standardization of Atlantic blue marlin caught by Japanese longliners by GLM, a positive relationship between CPUE of blue marlin and HPB was estimated mainly because of skewed distribution pattern of data and it caused an underestimation of the current level of CPUE (Yokawa, 2003). The negative relationships between CPUE of striped marlin and HPB observed in many areas would indicate the underestimation of current abundance level of the stock. On the other hand, an unnatural high value of estimated CPUE of shallow sets such as 3 – 4 HPB in areas 5 - 8 of the stratification 2 (Fig. 9) and 3 – 4 HPB in area 4 in stratification 4 would results in overestimation of actual abundance level. These high values would be affected by the striped marlin targeting operations.

Figure 11 shows historical change of the effect of the gear configuration on the CPUE. Negative relationship between CPUE and HPB were observed during the 1970's when shallower sets is major, and the relationship gradually changed into reverse ones as years go by and deeper sets become popular. These historical change of the relationship between CPUE and HPB would not reflect the change of catch ability of Japanese longliner gear nor the change of underwater behavior of striped marlin, but would only reflect the change of the operation pattern of Japanese longliners.

AIC and BIC values of CPUE standardizations by three different area stratifications indicate the stratification 1 is a best fit model among three, but detailed analysis of the results suggests that the estimated abundance index from the stratification 1 still contains biases coming from a skewed distribution pattern of data.

Further studies is necessary to obtain more reliable abundance index.

Reference

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Yokawa, K., 2005. Operation patterns of Japanese offshore and distant-water longliners in the North Pacific, whit emphasis on the billfishes. ISC/05/MAR&SWO-WGs/16, 19p.

Yokawa, K., M. Kanaiwa, Y. Takeuchi, and H. Saito, 2005. Vertical distribution pattern of CPUE for striped marlin in the north Pacific estimated by the with data of the time, depth and temperature recorders collected through a longline research cruise of Shoyo-maru in 2004 in the north east Pacific, preliminary results. ISC/05/MAR&SWO-WG/14, 15p.

Table 1. AIC and BIC values in the results of CPUE analysis.

1952 - 1980	AIC	BIC
Stratification 1	347176	350496
stratification 2	420220	423063
Stratification 3	362933	365941

1975 - 2004	AIC	BIC
Stratification 1	920918	924957
stratification 2	1194360	1198254
Stratification 3	1059354	1063573

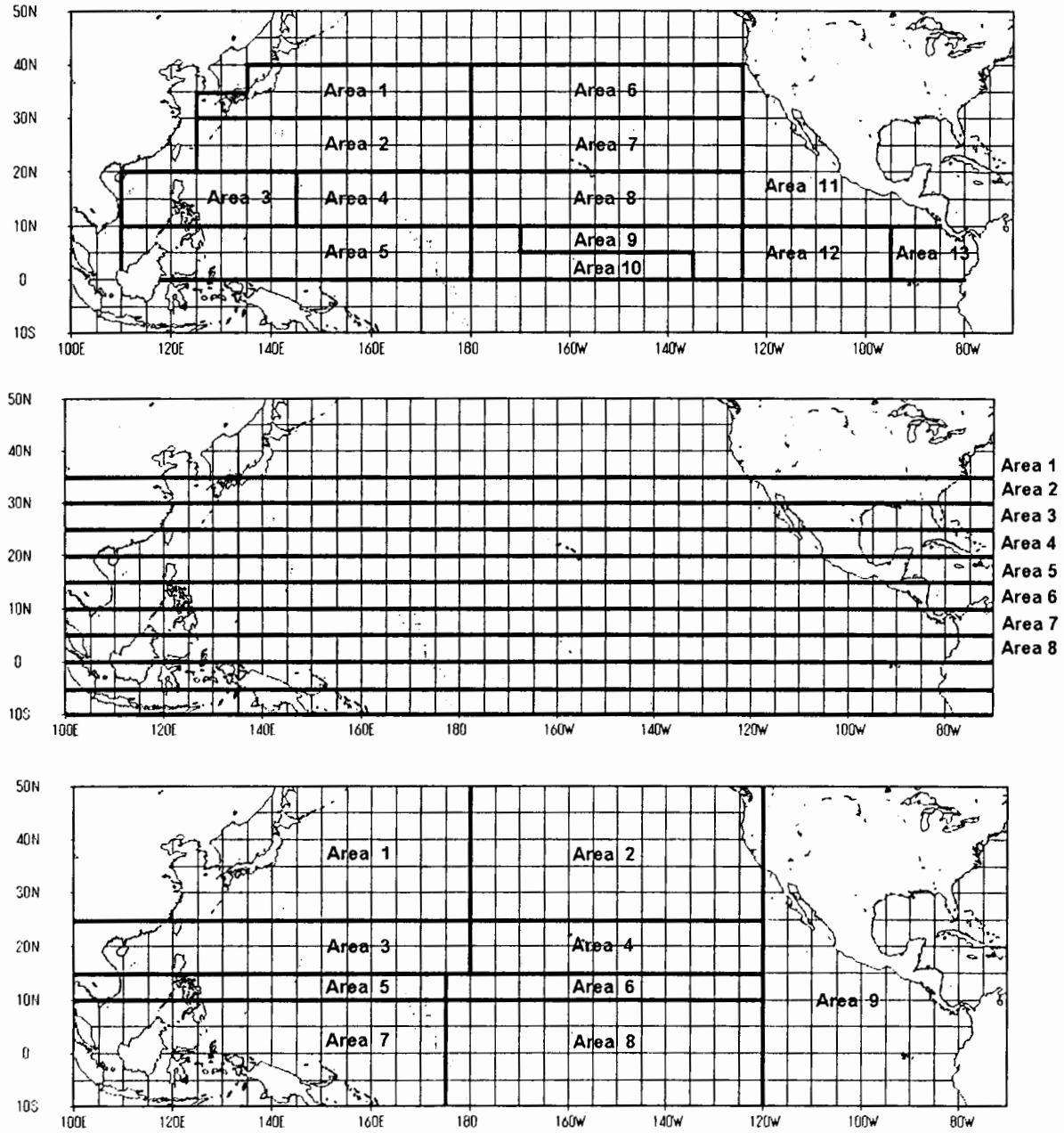


Fig. 1. Three area stratifications used in this study. Upper stratification (Stratification 1) made by subjective way, middle one (Stratification 2) made by CHAID, and bottom one (Stratification 3) made by ~~CHAID~~ CART. Southern, northern and western boundary of areas in Stratifications 2 and 3 are followed by ones in Stratification 1.

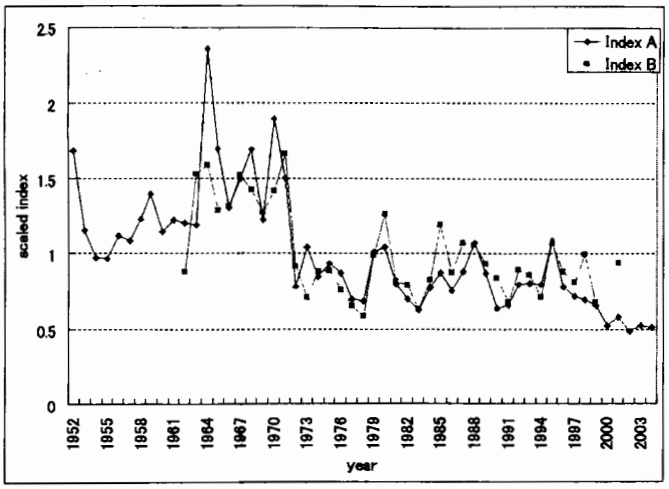


Fig. 2. Standardized CPUE calculated with the stratification 1. CPUE was standardized with data from selected area (areas 1-10 for 1952-1974, and areas 1-10 & 12 for 1975-2004) to get longest historical series (Index A), and also standardized with data form selected year (1962 – 1999 & 2001) to get largest area coverage (all area, Index B). All values were scaled to their averages which set at 1.0.

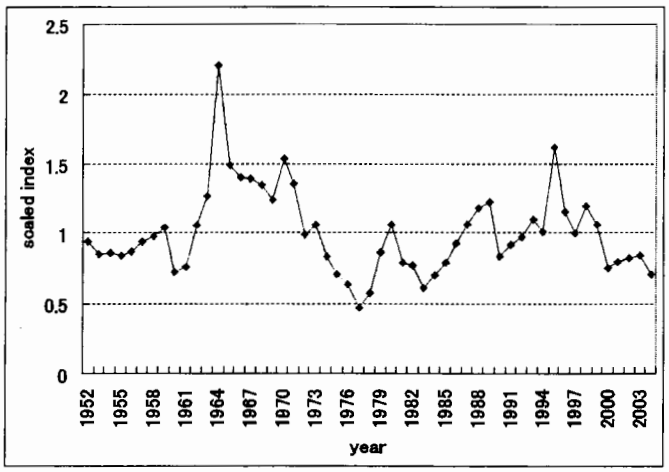


Fig. 3. Standardized CPUE calculated with the stratification 2. All values were scaled to their averages which set at 1.0.

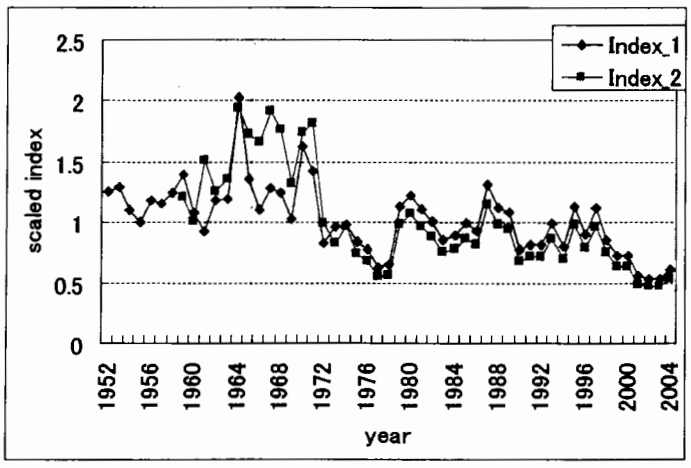


Fig. 4. Standardized CPUE calculated with the stratification 3. CPUE was standardized with data from selected area (areas 1-8 for 1952-1974) to get longest historical series (Index A), and also standardized with data form selected year (1959 – 2004) to get largest area coverage (all area, Index B). All values were scaled to their averages which set at 1.0.

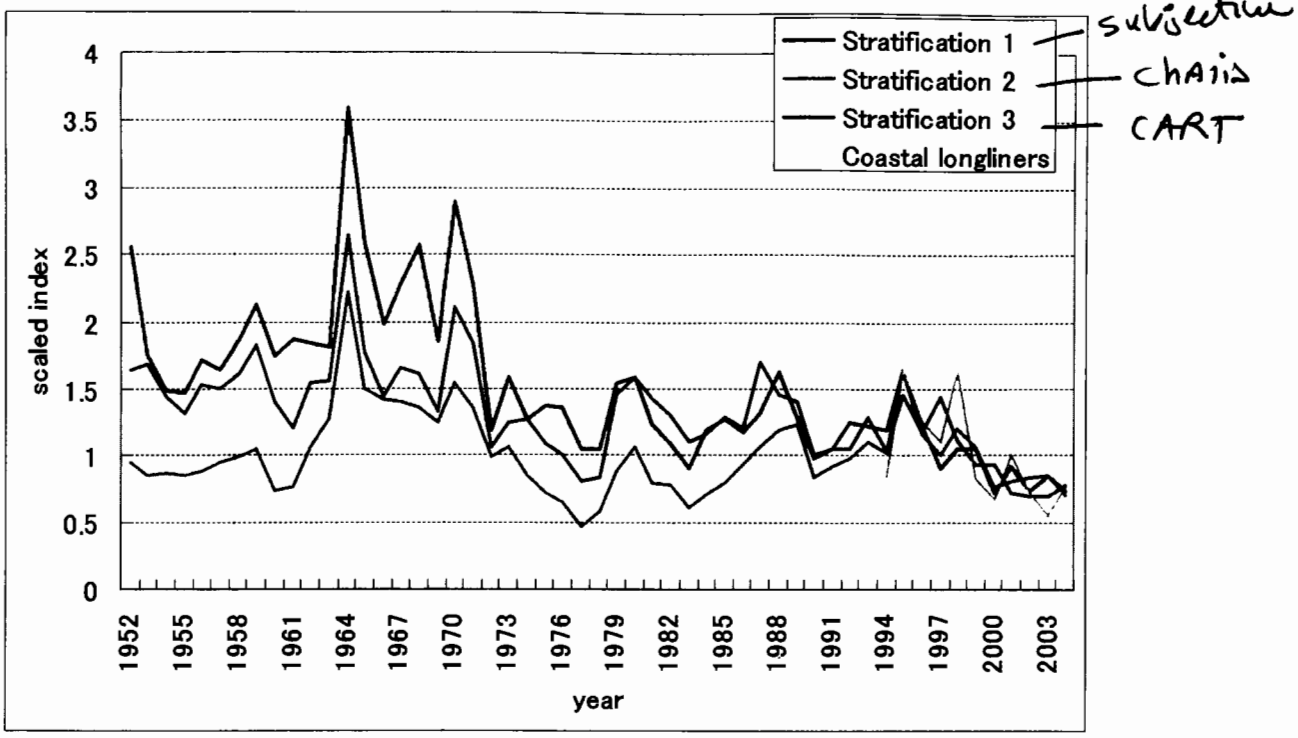


Fig. 5. Standardized CPUE of Japanese offshore and distant-water longliners (1952 - 2004) calculated with 3 area stratifications, and standardized CPUE of Japanese coastal longliners (1994 – 2004). All values were scaled to their average in 1994 – 2004 which set at 1.0.

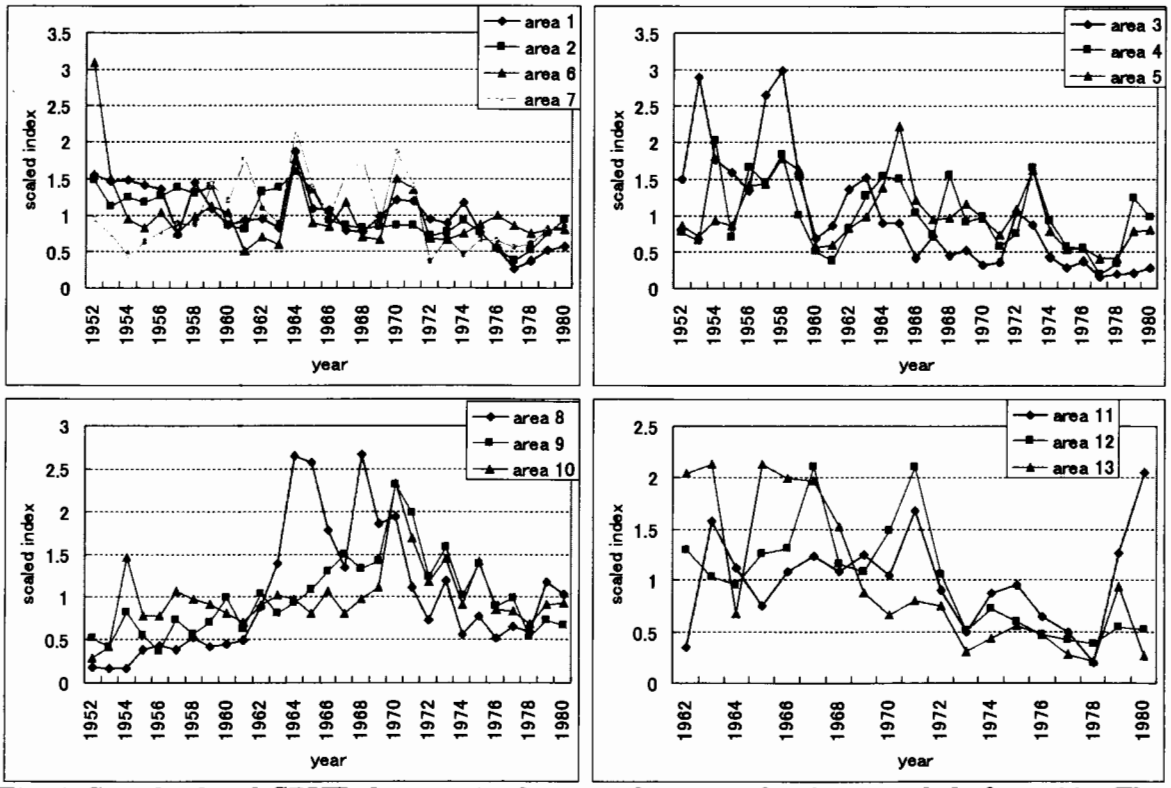


Fig. 6. Standardized CPUEs by area in the stratification 1 for the periods before 1981. The upper left panel shows CPUEs for the areas in the temperate Pacific, the upper right panel for the areas in the western tropical Pacific, the lower left panel for the areas in the central tropical Pacific, and the lower right panel for the areas in the eastern Pacific. All values were scaled to their averages which set at 1.0.

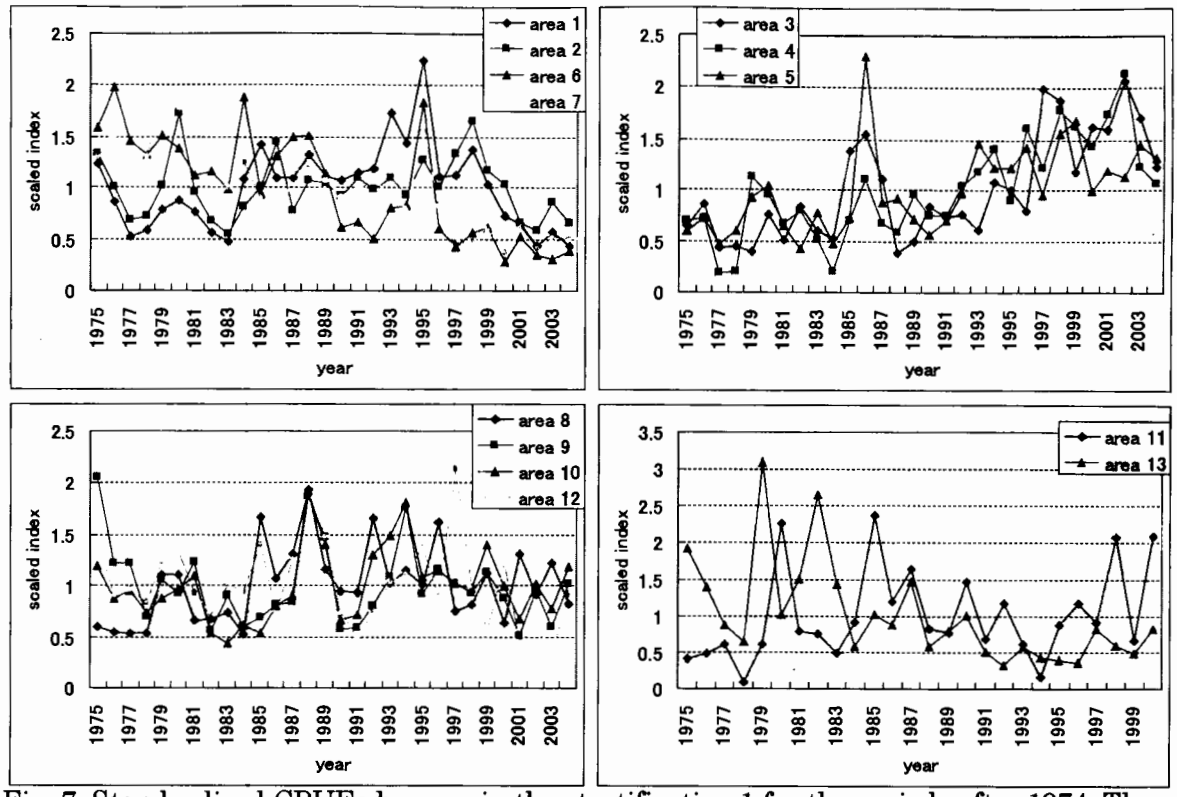


Fig. 7. Standardized CPUEs by area in the stratification 1 for the periods after 1974. The upper left panel shows CPUEs for the areas in the temperate Pacific, the upper right panel for the areas in the western tropical Pacific, the lower left panel for the areas in the central tropical Pacific, and the lower right panel for the areas in the eastern Pacific. All values were scaled to their averages which set at 1.0.

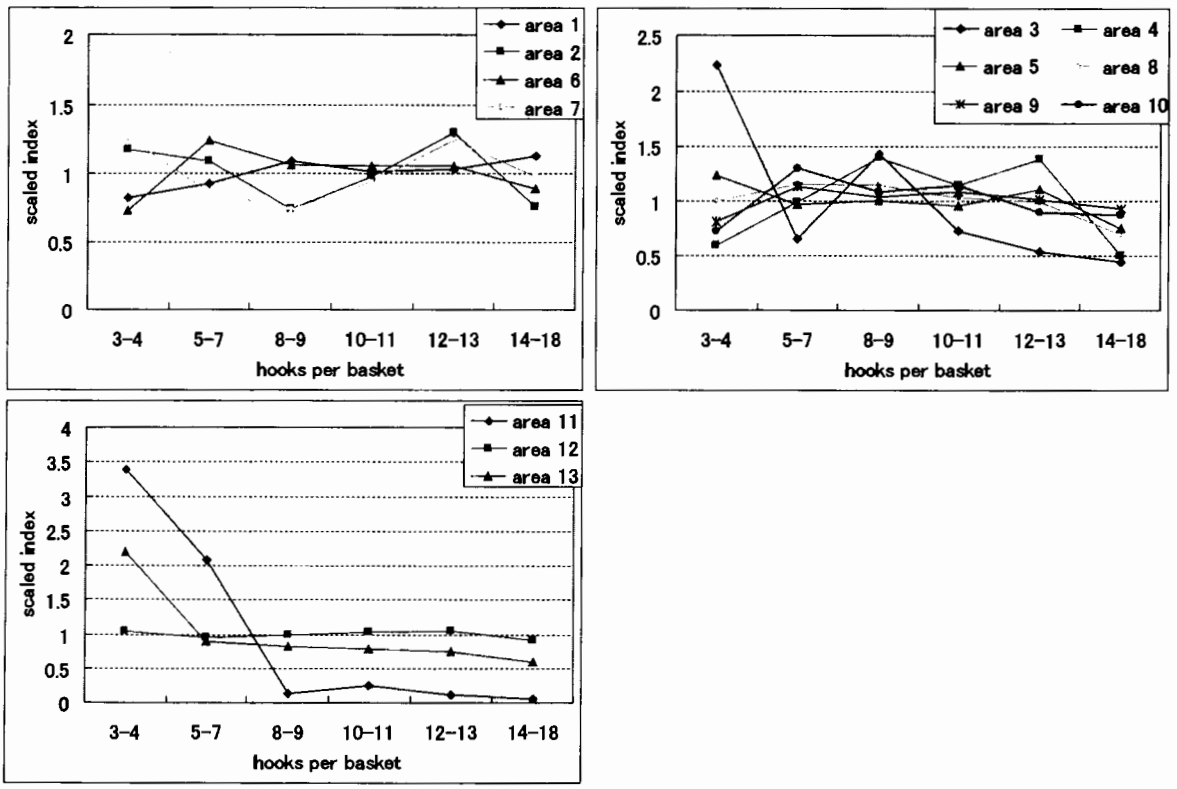
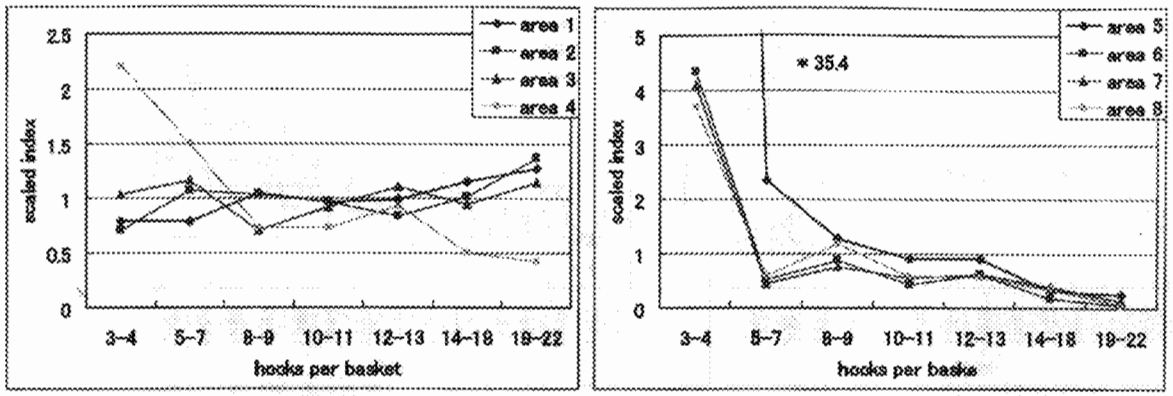
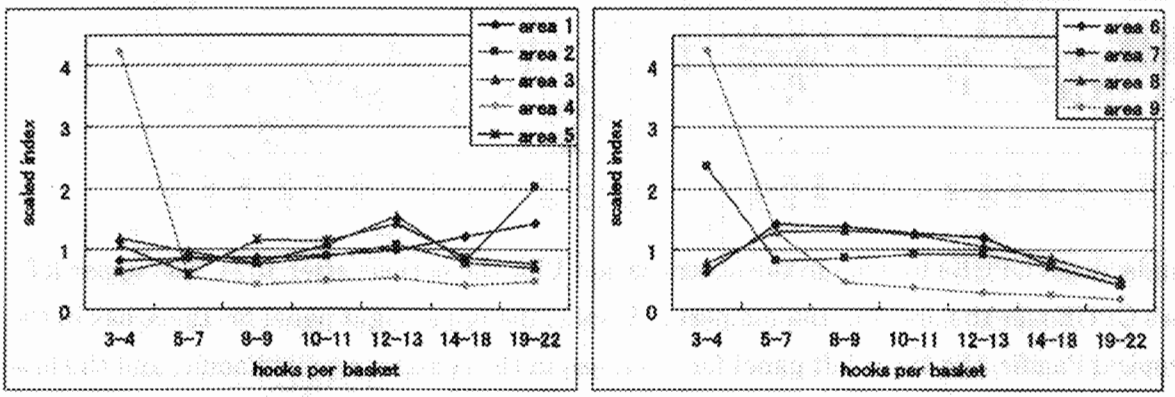


Fig. 8. Standardized CPUEs by gear configuration and by area in the stratification 1. Data for 1975 – 2004 were used. All values were scaled to their averages in 1994 – 2004 which set at 1.0.



CHAID Algor

Fig. 9. Standardized CPUEs by the gear configuration and by area in the stratification 2. Data for 1975 – 2004 were used. All values were scaled to their averages in 1994 – 2004 which set at 1.0.



CART Algor.

Fig. 10. Standardized CPUEs by the gear configuration and by area in the stratification 3. Data for 1975 – 2004 were used. All values were scaled to their averages in 1994 – 2004 which set at 1.0.

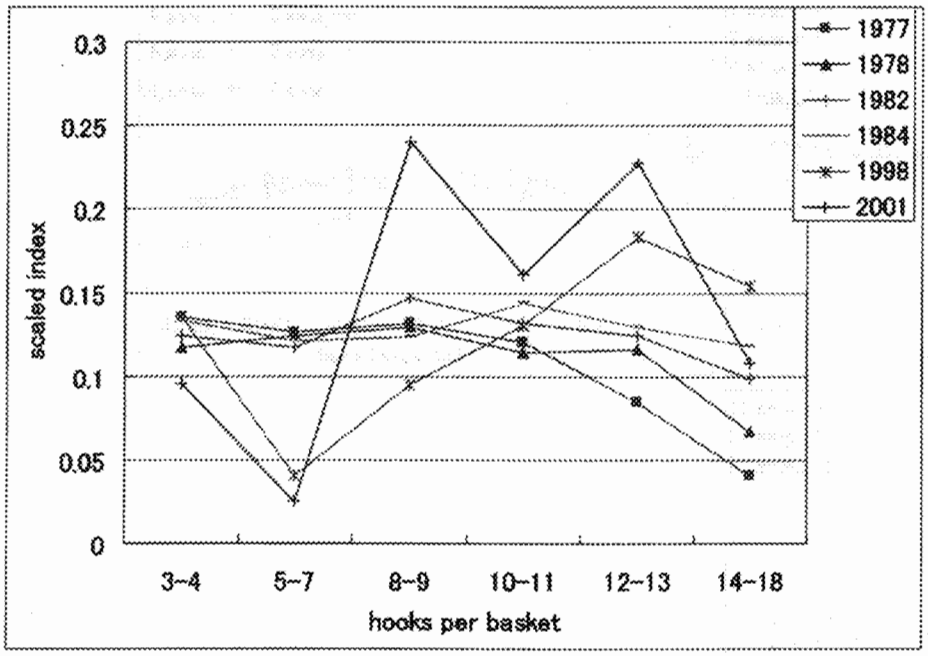


Fig. 11. Standardized CPUEs by gear configuration and by picked up year. CPUE were standardized by the stratification 1.